

## **CHAPTER 8**

### **COMBINED SUSPENDED AND ATTACHED GROWTH AEROBIC TREATMENT SYSTEMS**

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Combined processes are a hybridization of the activated sludge and attached growth systems, including packed beds, suspended carrier materials, and rotating biological contactors. In general, having a fixed film component has a buffering effect in the event of a process disturbance. Process disturbances may include extreme hydraulic overloading, discharge of toxic compounds into the system, or aeration system malfunction.

#### **Types of processes**

The principle types of processes may be classified as (1) Continuous flow suspended growth with fixed internal packing, (2) Continuous flow suspended growth with suspended internal packing, (3) Sequencing batch reactors with internal packing, and (4) Rotating biological contactor.

##### *Continuous flow suspended growth with fixed internal packing*

Wastewater moves through the system by hydraulic displacement, i.e., as water is discharged into the system, an equal volume flows out of the system. The fixed internal packing is generally a plastic matrix material designed to maximize fixed film microbial growth and contact with wastewater to be treated. In many cases, the aeration system is integrated with the fixed packing to achieve unique flow patterns.

##### *Continuous flow suspended growth with suspended internal packing*

Suspended packing materials can be designed to float or sink, depending on the specific process material. The attached growth moves throughout the water column in the treatment process, increasing the overall contact with the wastewater. The suspended packing is generally circulated in the aeration tank by currents induced by the aeration device.

##### *Sequencing batch reactors with internal packing*

In the sequencing batch reactor, wastewater is stored in the reaction chamber of the treatment system until a sufficient volume (a batch) is collected, at which point the treatment process begins. The batch of wastewater is seeded with an active bacterial culture (affixed to the support medium) and aerated for the treatment period. After the reaction is complete, aeration and mixing are stopped, and the flocculated bacteria and other solid particles settle out. The clear layer (supernatant) is discharged from the reaction chamber, and the next batch of wastewater to be treated begins to flow into the reaction chamber. The fill, react, settle, discharge cycle is repeated continuously.

##### *Rotating biological contactors*

A rotating disk is partially submerged in a flow through reactor. The attached microbial community is exposed to the wastewater with each revolution of the disk. The process is optimized by adjusting the speed of rotation and the depth of submergence.

#### **System components**

Important components of combined aerobic suspended and attached growth treatment systems are the reactor (container), the aeration and mixing devices, the medium used for microbial attachment, the outlet structure, and the control system. Each of these components is discussed below.

##### *Container*

The process tank is generally divided into three compartments, the primary separation chamber, the aeration chamber, and the settling chamber. Some systems accomplish primary treatment in a standard septic tank, making them suitable for upgrading sites that already have an existing septic system. The primary separation chamber is designed to separate settleable and floatable

substances from the influent wastewater. The primary separation compartment should be designed to have a capacity to retain materials that may interfere with downstream processes. The aeration chamber is designed to provide sufficient volume for contact between the wastewater and the microbial biomass. The distribution of the fixed film media, placement of the aeration device, and hydraulic flow paths are important criteria for effective treatment. Clarification is the separation of wastewater solids (particles and microbial cells) from the treated water. The secondary settling chamber is used for clarification of the wastewater and should be sized to provide adequate detention time for secondary separation before discharge of the treated water.

#### *Attached growth media*

The two basic types of configurations for the attachment of the microbial community are suspended packing and fixed packing. Suspended packing is generally made from a polymer that will remain buoyant in the treatment process. In case of a disruption in the aeration process, the buoyant packing will float to the surface of the liquid and remain partially aerobic. Fixed packing is typically a submerged bed of sand or synthetic media.

#### *Aeration and mixing devices*

Mixing and aeration are, in most cases, accomplished by the same device. Generally, air is delivered to the bottom of the aeration tank and released through a diffusing mechanism to increase the surface area and, thus, oxygen transfer efficiency, to the aerobic treatment process. As the air bubbles move up the water column, oxygen is consumed, and the contents of the tank are mixed. Important factors to be considered for the aeration mechanism are the (1) maintenance requirements, (2) expected lifespan and reliability, (3) noise generated during operation, (4) access to the device, and (5) durability under adverse conditions. The common types of aeration and mixing devices are presented in Table 8-1. Because these treatment processes are aerobic, the device or method used to compress and deliver air to the aeration tank is a critical element.

**Table 8-1**

Mixing and aeration devices used for onsite wastewater treatment systems

Device	Description
Air diffusers	Air diffusers are porous fixtures located in the aeration tank. Compressed air is pushed through the holes in the diffuser, causing the formation of discrete air bubbles. The compressed air may be supplied by a diaphragm, rotary vane, or piston pump (rated for continuous use).
Aspirators	Aspirators have a small impeller located below the end of a submerged hollow shaft (draft tube), when the impeller and shaft are rotated, a vacuum is created that draws air down the draft tube and into the aeration tank and is simultaneously disperses by the impeller into the water.
Air lift pumps	The air lift pump operates by injecting air into the bottom of a vertical submerged column (hollow shaft). The air that is released moves up the column and forces water to move upwards with it, accomplishing aeration and mixing.

#### *Outlet structures*

The outlet is designed to release clarified, treated water from the treatment system. The outlet structure should be designed to keep residual particles from exiting with the process effluent. Commonly used devices are baffled outlet structures, outlet (effluent) filters, and floating and fixed overflow weirs.

#### *Control systems*

Process control is generally accomplished by float switches to monitor the water level, pumps to transfer water between processes, and timers to regulate the treatment process. Many systems

are incorporating programmable logic controllers to make the treatment process more adaptable to the challenges of onsite treatment.

### Operational parameters

Operational parameters are used to define the system application. Most treatment processes are rated based on the daily hydraulic capacity for wastewater with an assumed composition. In some of the processes, the solids retention time (SRT) is also used as a control parameter. Because onsite treatment systems are often exposed to highly variable loading, processes are often oversized. A robust treatment process should provide design performance under a range of adverse loading conditions. The parameters used to categorize system operation include the loading rate, retention time, surge capacity, aeration characteristics, flow configurations, and process failure.

#### *Retention time*

Each process within a treatment process has a liquid retention time based on the effective volume of the process and the expected hydraulic loading rate (HLR). The various treatment processes and the importance of proper retention time are presented in Table 8-2. Most aerated onsite treatment processes are based on the concept of extended aeration to reduce the overall sludge volume, due to the difficulty in regular removal this material.

**Table 8-2**

Treatment processes and the importance of design retention time

Treatment process	Importance
Primary	Primary treatment processes require liquid retention time to accomplish solids separation from the water to be treated. If hydraulic overload occurs, solids may be carried over into subsequent processes, reducing the overall effectiveness of the treatment process.
Aeration	Contact time in the aeration cycle is needed to ensure design oxidation of the process water. If the water is not in the aeration process for a sufficient length of time, the effluent discharged may have an increased BOD or ammonia concentration.
Secondary	Secondary processing is designed to separate the biomass and other suspended materials from the wastewater to be discharged. If not given enough time for settling, these solids will be discharged with the wastewater and may interfere with downstream processes. Outlet filters have reduced the possibility of inadvertent solids discharge.
Solids	The solids retention time (SRT) is related to the length of time that the microbial biomass is kept in the treatment process. Because it is not realistic to remove solids from onsite treatment systems on a regular basis, they are often recycled back to the primary treatment process or the aeration process for digestion. Solids recycling is accomplished by allowing the settled solids to flow back into the aeration process by gravity or with a submerged pump that periodically activates and discharges the solids to a specified location.
Disinfection	For systems that incorporate a disinfection step, adequate contact time with the disinfectant needs to be ensured to accomplish design performance.

#### *Loading rate*

The loading rate is the flow of a material, such as liquid or a specific constituent, through the system. The HLR is often defined as the daily volume of wastewater that the system is able to process. The organic loading rate (OLR) is defined as the daily BOD<sub>5</sub> input to the system. For residential applications, the constituent concentrations for typical domestic wastewater are used

to estimate the OLR. Activities that can effect the loading rate include (1) variable loading, (2) over loading, (3) extended periods of non-operation, (4) electricity outage, and (5) equipment failure.

#### *Process failure*

Process failure occurs when the treatment system discharges water with constituent concentrations that are above the acceptable limit as determined by the effluent management system. The causes of failure in aerated treatment processes are often caused by (1) inadequate maintenance of the treatment system, (2) discharge of toxic substances (such as chlorine) to the biological treatment system, and (3) failure of a component (such as an aeration device) needed for proper operation. Of these, proper maintenance is believed to be the most important aspect of long-term success of onsite treatment systems.

### **Monitoring and maintenance**

The ongoing monitoring and maintenance of aerated treatment systems is important for keeping these devices operating as designed. Monitoring and maintenance activities should be conducted regularly by a certified individual.

The system components that should be inspected include the aeration device, the packing materials (if applicable), the inlet and outlet structures, pumps, and the air diffusers. Additional components may also need servicing as determined by the manufacturer. The system components and standard maintenance needs are presented in Table 8-3.

**Table 8-3**

Recommended maintenance activities for aerated treatment systems

Component	Typical maintenance needs
Aeration device	Check air filters and clean if necessary. Also check oil seals, noise level, abnormal vibration, and heating output.
Packing	Check media for debris or solids accumulation. Check for ponding and clogging of any associated component and clean as necessary.
Inlet and outlet structures	Remove floating debris and scum that accumulates around outlet structures.
Process tanks	Check for excessive solids accumulation and remove as needed.
Pumps	Confirm that pumps are operating correctly.
Diffusers	Inspect diffusers for solids buildup and clean as necessary.
Timers	Check system timers and other control devices for correct settings as determined by manufacturer or system installer.
Float switches	Observe float switches to confirm proper operation.
Alarms	Confirm that alarms are functioning.
Effluent quality	Qualitative assessment of odor, color, and turbidity. Qualitative assessment may depend on the discharge location and can include BOD, TSS, nitrogen, phosphorus, and fecal coliform bacteria.

### **8-1 Continuous flow suspended growth with fixed internal packing**

Submerged, aerated, packed beds that are used in aerated continuous flow systems. The stationary packed bed is available as a package system or as a supplement to the conventional septic tank.

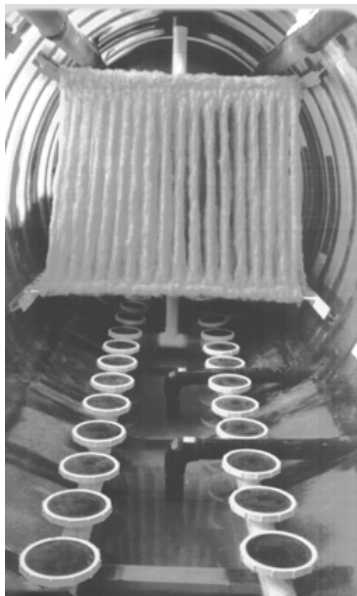


**8-1.1 Bio-fosse™**

Category	Primary and secondary treatment
Technology	Continuous flow, aerated attached growth
Input	Untreated wastewater
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual, community, and institutional systems

**Background**

Treatment system utilizes a patented material (Biotex™) for attached growth.

**Figure 8-1**

Biotex material placed inside Bio-fosse aeration chamber. (Adapted from Bioflo, Inc.)

**Contact**

Bioflo, Inc  
 2186 de la Province  
 Longueuil (Québec) Canada  
 Phone (450) 463-3388  
 Fax (450) 463-3711  
 E Info@bioflo.ca  
 Web www.bioflo.ca  
 Manufacturer support  
 10 year manufacturer warranty on Biotex material

**8-1.2 Biomax**

Category	Primary and secondary treatment
Technology	Continuous flow, aerated attached growth
Input	Untreated wastewater
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual, community, and larger systems

### Background

The Biomax system is a self contained treatment unit that utilizes a proprietary suspended growth media known as Ringlace™. The units are approved for use in Washington; however, limited information has been obtained at this time.

### Description of process

The Biomax treatment process makes use of anaerobic and aerobic chambers packed with media for attached biological growth and a clarifier for solids removal (chlorine disinfection unit optional).



**Figure 8-2**

The Biomax treatment unit prior to installation.  
(Adapted from Biomax Systems, Inc.)

### Contact

Brightwater Engineering Ltd.  
Brightwater House, Unit 2, Business Centre East  
Avenue One, Letchworth, Herts SG6 2HB  
Phone 01462 485 005  
Fax 01462 485 003  
E enquiries@brightwater.uk.com  
Web www.bordnamona.com/environmental/

### 8-1.3 BioSorb™ advanced wastewater treatment systems

Category	Secondary treatment, ozonation
Technology	Continuous flow, aerated attached growth
Input	Primary effluent (e.g., septic tank effluent)
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual, community, and larger systems

### Background

The BioSorb system is a prefabricated aerobic digester with an aerated attached growth medium. The process incorporates ozonation of effluent for water reuse (e.g., subsurface irrigation) purposes.

### Operation and maintenance

Air compressor and ozone disinfection units both require maintenance.

**Contact**

RGF Environmental  
3875 Fiscal Court  
West Palm Beach, FL 33404

Phone (800) 842-7771

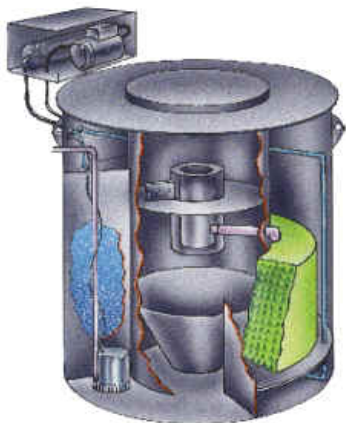
Fax (888) 848-0047

E rgf@rgf.com

Web www.rgf.com

Model description

Flow rates from 500 and larger.

**Figure 8-3**

A cut-away illustration of the Biosorb treatment unit. (Adapted from RGF Environmental, Inc.)

**8-1.4 BTX Biotreater™ systems**

Category	Secondary treatment
Technology	Continuous flow, aerated
Input	Primary treated wastewater
Function	Oxidation, nutrient transformation
Applications	Community, commercial, and industrial

**Background**

The BTX Biotreater system is a biological reactor with a corrugated fixed internal packing for attached growth. The system is designed for treatment of wastewater and contaminated groundwater.

**Contact**

Bioscience, Inc.  
1550 Valley Center Parkway  
Bethlehem, PA 18017

Phone (610) 974-9693

Fax (610) 691-2170

E bioscience@bioscience.com

Web www.bioscience.com

Model description

Wastewater treatment systems for flow rates from 2,500 (7 lb BOD/d) to 225,000 gal/d (470 lb BOD/d).

**8-1.5 EcoKasa wastewater treatment systems**

Category	Primary and secondary treatment
Technology	Continuous flow, aerated suspended growth
Input	Untreated wastewater
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual, community, and larger systems

**Background**

The EcoKasa system is a fixed bed attached growth reactor. System sizes range from serving an individual house to a large community. The system incorporates a unique sand filtration mechanism to reduce effluent suspended solids.

**Operation and maintenance**

Includes an air compressor that will require maintenance. Accumulated sludge may need to be removed periodically.

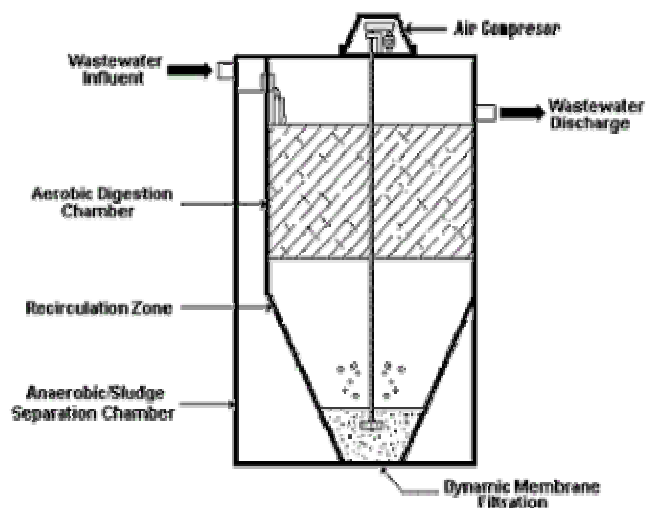
**Figure 8-4**

Diagram of the EcoKasa treatment system. (Adapted from EcoKasa, Inc.)

**Contact**

EcoKasa, Inc.  
 14910 Welcome Lane  
 Houston, Texas 77014  
 Phone (281) 580-7591  
 Fax (281) 880-9498  
 Web [www.ecokasa.com](http://www.ecokasa.com)  
 Model description  
     EcoKasa I  
     EcoKasa II  
     EcoKasa 1MP

**8-1.6 FAST wastewater treatment systems**

Category	Primary and secondary treatment
Technology	Continuous flow, aerated suspended/attached growth
Input	Untreated wastewater
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Recommended for individual, small community, and commercial systems. Offer alternate systems for advanced nitrogen and phosphorus removal, lagoons, and retrofits to existing systems.

**Background**

Bio-Microbics Inc. offers wastewater treatment systems for single family residences. The units are composed of a septic tank, fixed film media, and an air supply. Bio-Microbics also provides systems for applications such as lagoon treatment (LagoonFAST), retrofitting existing septic systems (RetroFAST), enhanced nitrification (NitriFAST), enhanced clarification (ABC-C), advanced nitrogen removal (ABC-N), and advanced phosphorus removal (ABC-P). Smith & Loveless custom design systems using the FAST technology for larger applications.

**Description of process**

The basic residential FAST system consists of a fixed-film media which is submerged in the second compartment of a modified, two-compartment septic tank. Air is supplied to the fixed-film process by a remote blower. Alternate modes of operation include recirculation of nitrified wastewater to the primary settling chamber for denitrification and intermittent operation of the blower to reduce electricity usage and increase denitrification.

**System footprint**

The system is integrated into a standard septic tank and therefore does not require additional space. The blower is generally located above grade in an area that will not be flooded or below grade in a vault (2 ft x 2 ft x 2 ft). The effluent meets secondary quality requirements and can be distributed to soil treatment system or disinfected for surface irrigation.

**Performance**

The Bio-Microbics FAST system has been evaluated in numerous research studies, as reported in Table 8-4. Depending on the treatment objectives, various systems are available for advanced nitrogen and phosphorus removal using chemical addition.

**Advantages**

The treatment unit can be installed in a standard septic tank. The space requirements are not greater than a standard septic tank. Performance data for the FAST system is available from multiple studies.

**Disadvantages**

Requires the use of a blower to supply air to the treatment process.

**Operation and maintenance**

The FAST systems incorporate a blower that will need periodic monitoring. The air intake filter for the blower will need to be cleaned. The blower is equipped with an alarm to signal in the event that the blower malfunctions. Sludge removal will also be needed on a periodic basis, approximately every one to three years.

**Power and control**

Annual electrical needs expected to be 2,000 to 3,000 kWh.

### Cost

Basic system (MicroFAST 0.5) costs \$3,000, and includes the capital cost for the FAST system, blower, blower housing, and control panel.

**Table 8-4**

Selected representative studies of Bio-Microbics FAST system performance

Parameter	Unit	Location of study			
		Ventura CA <sup>a</sup>	Mass <sup>b</sup>	Florida <sup>c</sup>	Rhode Island <sup>d</sup>
Description of system		Demonstration	Demonstration	Test facility	Home system
HLR	gal/d	365	330	307	214
System performance <sup>e</sup>					
BOD <sub>5</sub>	mg/L	13 (93%)	18 (90%)	3.7 (97%)	15
TSS	mg/L	5.9 (97%)	12 (92%)	3.9 (96%)	9
TN	mg/L	20.4 (34%)	15.5 (55%)	11.5 (76%)	20
NO <sub>3</sub> -N	mg/L	15		10.34	
NH <sub>3</sub> -N	mg/L	1.2			
P	mg/L	2.7 (16%)		6.62 (24%)	
Fecal coliform	MPN/100 mL	>1600	5E4 (1.6)		2E4

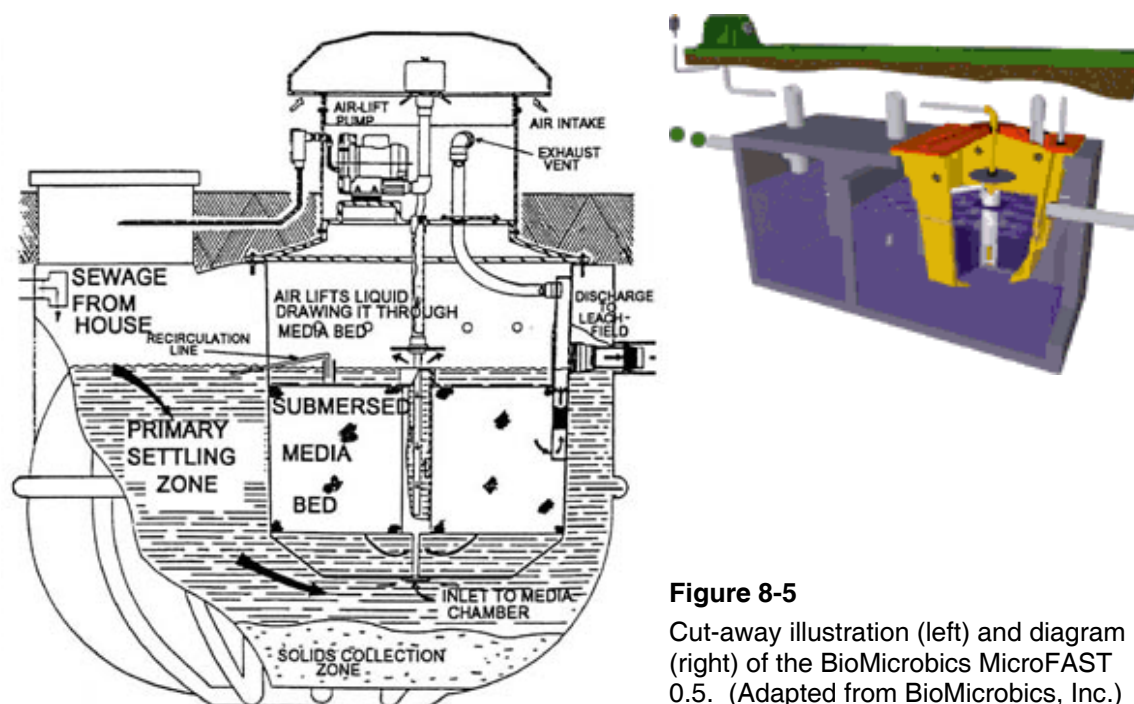
<sup>a</sup> Loomis *et al.* (2001); note operation was modified to evaluate reduced blower operation, resulting in higher effluent concentrations than under normal operating conditions.

<sup>b</sup> Ventura County Sanitation District (2001)

<sup>c</sup> Massachusetts Alternative Septic System Test Center (2001)

<sup>d</sup> Florida Department of Health (2000)

<sup>e</sup> Performance reported as average effluent concentration with average removal in parentheses, except microorganism removal, which has logs of removal reported in parentheses.



**Figure 8-5**

Cut-away illustration (left) and diagram (right) of the BioMicrobics MicroFAST 0.5. (Adapted from BioMicrobics, Inc.)

### Contact

Bio-Microbics, Inc.  
8450 Cole Parkway  
Shawnee, KS 66227  
Phone (913) 422-0707; (800) 753-FAST  
Fax (913) 422-0808  
E onsite@biomicrobics.com  
Web www.biomicrobics.com

### Model description

MicroFAST 0.5, 0.9, 1.5, 3.0, 4.5, 9.0 (for domestic wastewater flows from 500 to 9000 gal/d)  
HighStrengnthFAST 1.0, 1.5, 3.0, 4.5, 9.0 (for commercial wastewater flows from 1000 to 9000 gal/d)  
RetroFast 0.25, 0.375 (for existing standard septic systems with wastewater flows from 250 to 375 gal/d)  
LagoonFast 1.5, 3.0, 4.5, 9.0 (for lagoon treatment systems with flows from 1500 to 9000 gal/d)  
NitriFAST 0.5, 1.0, 1.5, 3.0, 4.5, 9.0 (for nitrification of high nitrogen wastewater with flows from 500 to 9000 gal/d)  
ABC-C 0.5, 1.0, 1.5, 3.0, 4.5, 9.0 (for clarification of wastewater with flows from 500 to 9000 gal/d)  
ABC-N 0.5, 1.0, 1.5, 3.0, 4.5, 9.0 (chemical addition for advanced removal of nitrogen from wastewater with flows from 500 to 9000 gal/d)  
ABC-P 0.5, 1.0, 1.5, 3.0, 4.5, 9.0 (chemical addition for advanced precipitation of phosphorus from wastewater with flows from 500 to 9000 gal/d)

### Manufacturer support

Bio-Microbics manufactures an assortment of systems that are based on a patented process for wastewater treatment. The systems are distributed and installed by approved organizations. Bio-Microbics provides equipment and controls for the gravity based systems, additional pumps and components for other configurations obtained locally. Company covers materials and workmanship for two years from date of installation or three years from date of shipment.

Smith & Loveless, Inc.  
14040 Santa Fe Trail Drive  
Lenexa, KS 66215-1284  
Phone 913-888-5201  
Fax 913-888-2173  
E answers@smithandloveless.com  
Web www.smithandloveless.com

### Model description

Smith & Loveless offer the Modular FAST system for larger flows (>10,000 gal/d), serving domestic, commercial, and industrial needs.

### References and other resources

Anderson, D.L., M.B. Tyl, R.J. Otis, T.G. Mayer, and K.M. Sherman (1998) Onsite Wastewater Nutrient Reduction Systems (OWNRS) for Nutrient Sensitive Environments, *Proceedings of the Eight National Symposium on Individual and Small Community Sewage Systems*, Orlando, FL.

Bio-Microbics (2001) Manufacturer information.

Loomis, G.W., D.B. Dow, M.H. Stolt, L.T. Green, and A.J. Gold (2001) Evaluation of Innovative Onsite Wastewater Treatment Systems in the Green Hill Pond Watershed, Rhode Island – A

NODP II Project Update, *Proceedings of the Ninth National Symposium on Individual and Small Community Sewage Systems*, Fort Worth TX.

Massachusetts Alternative Septic System Test Center (2001) Technology Fact Sheet Interim Findings, MicroFAST Model 0.5.

Florida Department of Health (2000) *Florida Keys Onsite Wastewater Nutrient Reduction Systems Demonstration Project – Phase II Addendum*, Florida Department of Health.

NSF International (1997) Report on Evaluation of Scienco/FAST Model 23-001-750, NSF International, Ann Arbor, MI.

Ventura Regional Sanitation District (2001) Septic Tank Nutrient Removal Project, Advanced Onsite Sewage Disposal System Demonstration.

U.S. EPA (2001) *CEIT Virtual Trade Show: Fast Wastewater Treatment Systems* (available at [www.epa.gov/region1/steward/ceitts/wastewater/techs/fast.html](http://www.epa.gov/region1/steward/ceitts/wastewater/techs/fast.html)).

### 8-1.7 JET BAT™

Category	Primary and secondary treatment
Technology	Continuous flow, aerated suspended growth
Input	Untreated wastewater
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual, community, and larger systems

#### Background

The JET 1500 Series treatment system is available in 5 models (500, 750, 1000, 1250, and 1500) serving flow rates from 500 to 1,500 gal/d. The J-500 and J-750 systems are single reactors divided into three sections. The J-1000, J-1250, and J-1500 models are composed of two separate tanks, a pretreatment tank (divided into two sections) and a treatment unit (divided into three sections). The J-500 model is described below.

#### Description of process

Household wastewater flows into the primary treatment section. As new water enters the system, an equal amount of water is displaced through the system. After sedimentation the liquid is aerated and exposed to the fixed packing and associated microbial community. The water is then settled in the clarification chamber and a fixed surface baffle keeps surface particles from flowing out in the effluent.

#### System footprint

The unit has a length of 10 ft, width of 5 ft, and depth of 5.75 ft. A standard soil treatment system is used for subsequent effluent management.

#### Advantages

All treatment occurs in single tank (for models J-500 and J-750). The fixed film media prevents washout of bacterial culture. There is only one mechanical component (aeration device).

#### Disadvantages

Limited performance data is available. Backup of wastewater into the unit (due to soil clogging or high water event) may damage the aeration device.

#### Performance

The Jet treatments systems J-500 through J-1500 have been certified under the NSF program. Additional performance data are provided in Table 8-5.



### Operation and maintenance

The unit will need to have sludge removed periodically. The aeration device will need to be replaced upon failure (manufacturer offers a 20 year factory exchange on aeration unit). Other potential maintenance activities include media and tank cleaning, testing the circuit breaker, and checking the various system components.

### Power and control

The only mechanical/electrical component is the aerator. Expected annual power usage is estimated to be 1,000 to 1,500 kWh.

**Table 8-5**

Reported performance of JET Model 500

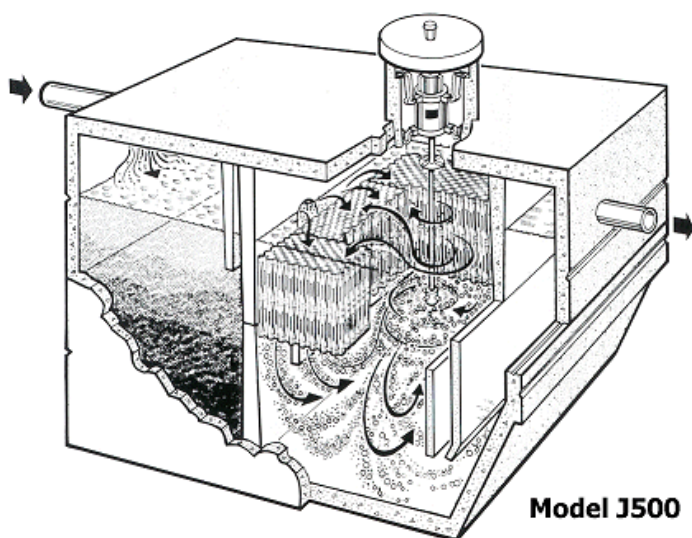
Parameter	Unit	Location of study <sup>b</sup>
		Mass
Description of system		Pilot testing
BOD <sub>5</sub>	mg/L	23 (88%)
TSS	mg/L	24 (88%)
TN	mg/L	25.6 (35%)
TP	mg/L	7.6 (17.4%)

<sup>a</sup> Performance reported as average effluent concentration with average removal in parentheses.

<sup>b</sup> U.S. EPA (2001).

### Cost

The estimated cost for the model J-500 is \$6,000 (residential application). An additional cost will be required for installation, shipping, and electrical work.



**Figure 8-6**

Cut-away illustration of the JET Model J-500 wastewater treatment system. (Adapted from Jet, Inc.)

**Contact**

JET, Inc.  
 750 Alpha Dr.  
 Cleveland, OH 44143  
 Phone (440) 461-2000  
 Fax (440) 442-9008

**Model description**

J-500 (500 gal/d)  
 J-750 (750 gal/d)  
 J-1000 (1000 gal/d)  
 J-1250 (1250 gal/d)  
 J-1500 (1500 gal/d)

**Manufacturer support**

JET recommends regular maintenance every six months. After installation, the JET distributor provides inspection and servicing for the treatment system for two years (included in the purchase price of unit) on a six month basis. Inspection includes confirming operation, cleaning, and effluent analysis. However, the service policy does not include sludge removal. JET recommends maintaining a service contract after the initial two-year agreement expires.

**References and other resources**

JET (2002) *Owner's Manual: 1500 Series Media Plants and All Other Models*, JET Inc., Cleveland, OH.

U.S. EPA (2001) *CEIT Virtual Trade Show: JET Aerobic Treatment System* (available at [www.epa.gov/region1/steward/ceitts/wastewater/techs/jetaerobic.html](http://www.epa.gov/region1/steward/ceitts/wastewater/techs/jetaerobic.html)).

**8-1.8 Pirana**

Category	Secondary treatment
Technology	Continuous flow, aerated attached growth
Input	Primary effluent
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual septic systems, failed systems

**Background**

The Pirana system is an aerated fixed film reactor that is submerged into the first or second chamber of an existing septic tank. In addition, the treatment system utilizes a bacterial culture to promote advanced digestion of wastewater solids.

**Description of process**

The fixed film reactor, submerged in a standard septic tank, receives air from a remote air pump. The system is inoculated with a microbial community that attaches to the medium and is suspended in the septic tank. Direct aerobic denitrification activity has been identified as resulting in exceptionally low effluent nitrogen. An outlet filter further protects the soil treatment system from high solids loading.

**System footprint**

A small watertight basin is used to house the air pump; otherwise the system does not require any additional space beyond a standard septic tank. The effluent can be distributed to a standard soil treatment system.

### Advantages

The system fits into a standard septic tank with minimal site disturbance. Expected high level of treatment and manufacturers claims that sludge removal from the septic tank will not be needed.

### Disadvantages

Operation requires the use of an air pump to supply air. Bacterial culture will need to be regenerated periodically (typically every 6 to 12 months).

### Operation and maintenance

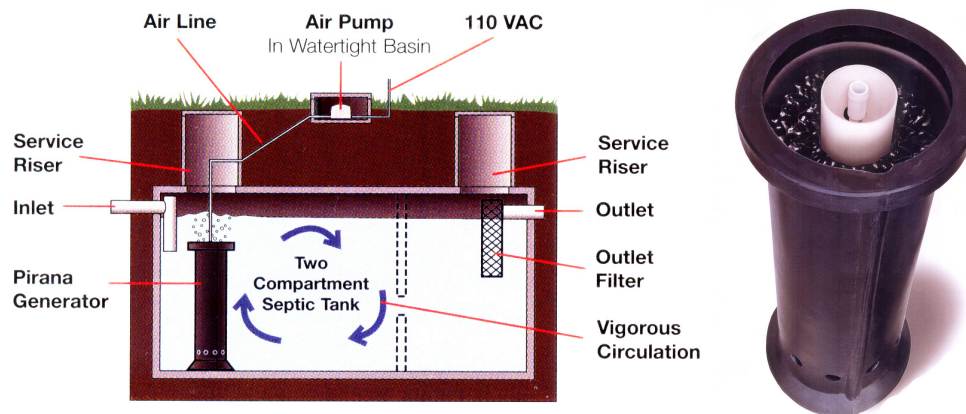
The air compressor will require standard maintenance. The specialty bacterial culture requires addition on regular basis (6 months). The manufacturer claims septic tank will not require sludge removal due to complete solids digestion in septic tank. The system should be inspected periodically to make sure all components are functioning correctly.

### Power and control

Estimated annual power usage for air pump is 400 to 500 kWh.

### Cost

System cost ranges from \$3,000 to 4,000 for the Pirana unit and septic tank.



**Figure 8-7**

Diagram of the Pirana wastewater treatment system (left) and a photo of the Pirana generator (right). (Adapted from Pirana, Inc.)

### Contact

Piranaco Company  
 Phone (707) 824-1170  
 Fax (707) 824-8154  
 E Pirana@monitor.net

### 8-2 Continuous flow with internal suspended packing

The continuous flow reactor can be equipped with a suspended packing. The suspended packing is used as a carrier for treatment organisms. The typical configuration is composed of a tank with two or more chambers. In the aeration chamber the suspended packing circulates with the water current. Many packing materials are designed to float to the surface when the water is not circulating, which may protect the aerobic organisms in the event of a power outage.

**8-2.1 BioGreen™ wastewater treatment systems**

Category	Primary and secondary treatment
Technology	Continuous flow, aerated fixed-film suspended growth
Input	Primary effluent (septic tank effluent)
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual and cluster residential

**Background**

The BioGreen system was developed in Japan and has been used there for many years. The basis of the system is a series of aerated, fixed-film reactors. The treatment process uses air lift pumps to aerate and transfer the water between the various processes.

**Description of process**

After passing through the septic tank, wastewater passes through an upflow attached growth anaerobic (fermentation) reactor. After passing through the anaerobic reactor, the wastewater is exposed to a series of aerated suspended packing reactors. The effluent from the aeration chambers enters a secondary settling process and is then discharged to a soil treatment or alternate effluent management system.

**System footprint**

The treatment system requires an area of 50 ft<sup>2</sup> in addition to a standard septic system.

**Advantages**

The BioGreen system has provided effective treatment in long term performance studies.

**Disadvantages**

Operations requires an air compressor.

**Performance**

The BioGreen units have provided effective treatment as determined from effluent samples drawn at actual installations. Typical effluent characteristics are summarized in Table 8-6.

**Table 8-6**

Effluent quality from BioGreen unit after  
4 years of operation (Enviroaccess, 1996)

Parameter	Unit	Influent	Effluent	Removal
BOD5	mg/L	152	3.9	97%
TN	mg/L	54.7	27.3	50%
TP	mg/L	7.32	4.83	34%

**Operation and maintenance**

Maintenance is recommended every six months, including quantitative effluent analysis and blower inspection. If needed, system can be backwashed to flush out accumulated solids. Air supply and effluent pumps inspected for proper operation. Sludge removal as needed.

**Power and control**

The air compressor (with low pressure alarm), level control and high water level switches, and systems alarms have an estimated annual electricity usage of 2,000 to 2,500 kWh.

**Cost**

The estimated cost for a residential system is \$14,000 to 17,000. The cost includes septic system, air compressor, float switches, control panel, one year service contract, and chlorine

disinfection unit. The cost does not include installation, electrical needs, soil treatment system, taxes, engineering and permitting fees, or shipping.

#### Contact

BioGreen Systems (Pacific) Ltd.  
11443 Kingston St  
Maple Ridge BC V2X 0Y6 Canada  
Phone (604) 460-0203  
Fax (604) 460-0263  
E biogreen@lynx.bc.ca

#### Model description

BG-2000 (400 gal/d)  
BG-3000 (600 gal/d)  
BG-4000 (800 gal/d)

#### Manufacturer support

The BioGreen systems includes the first year of maintenance in the purchase price of the unit, with an option to extend the service agreement after the first year.

#### References and other resources

Enviroaccess (1996) Environmental Technologies Fact Sheets: BioGreen, Center for Environmental Technologies, (available at [www.enviroaccess.ca/fiches\\_3/FA3-01-96a.html](http://www.enviroaccess.ca/fiches_3/FA3-01-96a.html)).

### 8-2.2 Eco-Kleen™

Category	Primary and secondary treatment
Technology	Continuous flow, aerated attached growth
Input	Untreated wastewater
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual, community, and larger systems

#### Background/description of process

The Eco-Kleen process includes anaerobic and aerobic chambers packed with media for attached biological growth, a clarifier for solids removal, and a sand filter for effluent polishing.

#### Contact

Eco-Kleen Systems Inc.  
6-12444 Harris Road; Pitt Meadows, BC  
Belfair, WA 98528  
Phone (604) 465-5911  
Fax (604) 465-4380

### 8-2.3 EnviroServer™

Category	Primary and secondary treatment, disinfection, sludge processing
Technology	Continuous flow, aerated suspended and attached growth
Input	Untreated wastewater
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Residential, commercial, light industrial

#### Background

The EnviroServer system is a continuous flow system that includes features for sludge elimination, remote monitoring, and disinfection. The treatment units have been evaluated in several studies with excellent results. MicroSepTec ensures system operation by requiring a monitoring and management agreement for all systems.

### Description of process

The EnviroServer unit is divided into four sections. The first compartment is for primary treatment and flow equalization. The second and third compartments contain a suspended packing material for attached growth. Aeration to the second and third compartments results in oxidation and nitrification of the process wastewater. The last compartment of the unit is for secondary clarification. Sludge from the secondary clarification compartment is returned to the primary treatment chamber with an intermittent recirculation pump. Secondary effluent flows through a tablet chlorinator and into a chlorine contact/pump basin.

### System footprint

The standard household system is 14 ft long and 5 ft in diameter. Effluent is suitable for discharge to most soil based treatment/adsorption systems. Effluent may require dechlorination in some areas.

### Performance

The performance of the EnviroServer system has been characterized through evaluation by NSF (2000), at UC Riverside by Wistrom and Matsumoto (1999), and by the Ventura Regional Sanitation District (2001). Performance specifications of representative research findings are presented in Table 8-7.

**Table 8-7**

Selected representative studies of MicroSepTec EnviroServer system performance

Parameter	Unit	Location of study		
		Ventura CA <sup>a</sup>	UC Riverside <sup>b</sup>	Manufacturer claim <sup>c</sup>
Description of system		Demonstration	10 week performance evaluation	Product brochure
HLR	gal/d	365	156	
pH	unitless		8	7.5
System performance <sup>d</sup>				
COD	mg/L		54 (93%)	
BOD <sub>5</sub>	mg/L	4.6 (97%)	5.7 (97%)	<10 (95%)
TSS	mg/L	10 (96%)	5.9 (98%)	<10 (97%)
TN	mg/L	16 (47%)	9.1 (79.4)	<10 (75%)
NO <sub>3</sub> -N	mg/L	10	2.1	
NH <sub>3</sub> -N	mg/L	1	0.1	
TP	mg/L	3.1 (3%)	2 (89%)	
Fecal coliform	CFU/100 mL	220	<2 (5.4)	<2.2 (9.6)
Total coliform	CFU/100 mL	358	<2 (5.6)	

<sup>a</sup> Manufacturer supplied information (2002).

<sup>b</sup> Ventura County Sanitation District (2001).

<sup>c</sup> Wistrom and Matsumoto (1999).

<sup>d</sup> Performance reported as average effluent concentration with average removal in parentheses, coliform data reported as effluent concentration and log removal in parentheses.

### Advantages

System produces a high quality effluent. The EnviroServer is a complete treatment system,

including disinfection and sludge removal. All systems include a telemetry monitoring and management contract and enhanced manufacturer support.

### Disadvantages

Residual chlorine in effluent may not be suitable for discharge in some areas. The system utilizes more mechanical and electrical components than most other systems.

### Operation and maintenance

Electrical components include two blower units, three pumps (sludge, recirculation, and effluent), a thermal sludge processing unit, and a process control/monitoring system. See description of management and monitoring specification below. No O&M for homeowner besides proper usage. Two-year system monitoring and management is included in the purchase price. Long term management and monitoring required.

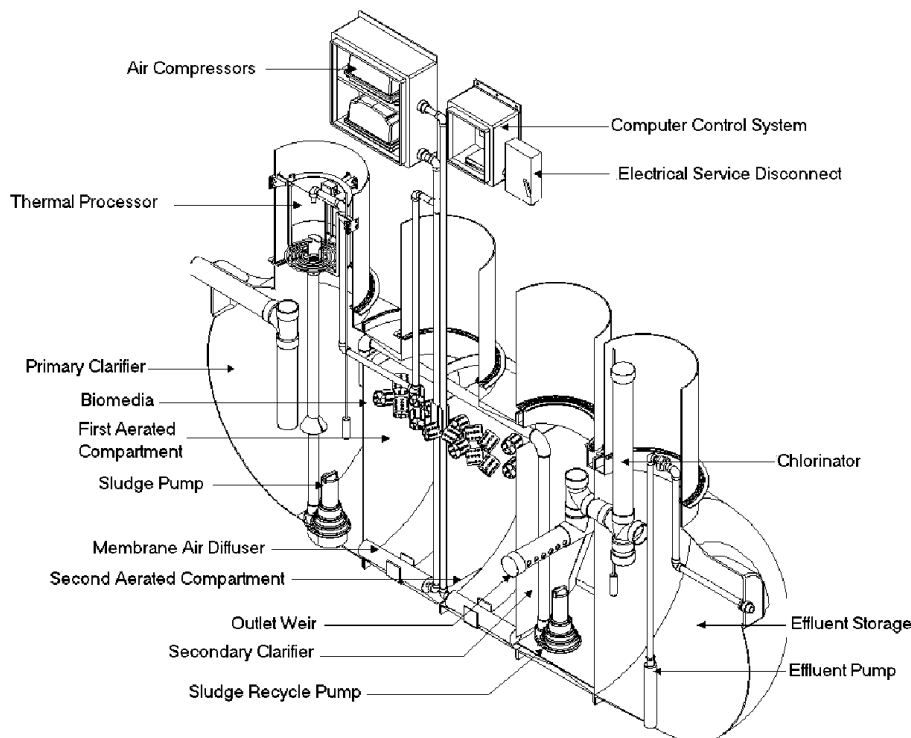
### Power and control

System includes a sludge pump, a recirculation pump, an effluent pump, two air compressor units, a thermal sludge processing unit, and a monitoring and control system. The estimated annual electrical usage for the EnviroServer 600 is 2160 kWh.

The monitoring system includes detection for high water level, pump failure, air compressor failure, sludge processing unit failure or high temperature, thermocouple failure, chlorine residual (disinfection failure), and overall monitoring system failure (by not responding at required interval).

### Cost

The estimated cost for the EnviroServer 600 (600 gal/d) system is \$10,900, and includes the capital cost of all system components sold as a complete unit.



**Figure 8-8**

Diagram of the EnviroServer by MicroSepTec. (Adapted from MicroSepTec, Inc.)

**Contact**

MicroSepTec  
 23112 Alcalde Dr, Suite C  
 Laguna Hills, CA 92653  
 Phone (949) 855-3500  
 Fax (949) 855-3515  
 Web www.microseptec.com  
 Model description

MicroSepTec offers three complete units:

EnviroServer 600 (600 gal/d)

EnviroServer 1200 (1200 gal/d)

EnviroServer 1500 (1500 gal/d)

**Manufacturer support**

Each system is sold with a mandatory maintenance and monitoring contract. The maintenance and monitoring contract is held as a permanent agreement against the property. The first two years of maintenance, monitoring, and complete parts warranty are included in the purchase price of the unit. After the first two years, the owner is required to pay a \$28/month service fee, covering maintenance and monitoring.

MicroSepTec uses a telemetry system for continuous (24 hour) monitoring.

**References and other resources**

Edvardsson, C.M., and T.G. Edvardsson (2001) E-connected Onsite Management for Advanced Treatment Units, National Onsite Wastewater Recycling Association (NOWRA) Conference.

NSF (1999) Final Report: EnviroServer 600 Wastewater Treatment System, NSF International, Ann Arbor, MI.

Wistrom, A.O., and M.R. Matsumoto (1999) Evaluation of MicroSepTec EnviroServer Residential Wastewater Treatment System, University of California, Riverside.

Ventura Regional Sanitation District (2001) Septic Tank Nutrient Removal Project, Advanced Onsite Sewage Disposal System Demonstration.

**8-2.4 Nibbler™ Wastewater Treatment Systems**

Category	Primary and secondary treatment
Technology	Continuous flow, aerated suspended growth
Input	Untreated wastewater
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual and cluster residential, commercial

**Background**

The Nibbler wastewater treatment system was developed for the treatment of wastewaters with higher oxygen demand than typical residential wastewaters, such as commercial facilities. The Nibbler technology is the basis for three wastewater treatment systems:

Nibbler Jr.	For residential and light commercial applications, pretreatment and renovation of failed systems.
Nibbler Lite,	For high strength waste treatment and flow rates in the range of 500 to 1,200 gal/d.
Nibbler.	For the pretreatment of high strength waste with flows ranging from 1,000 to 25,000 gal/d

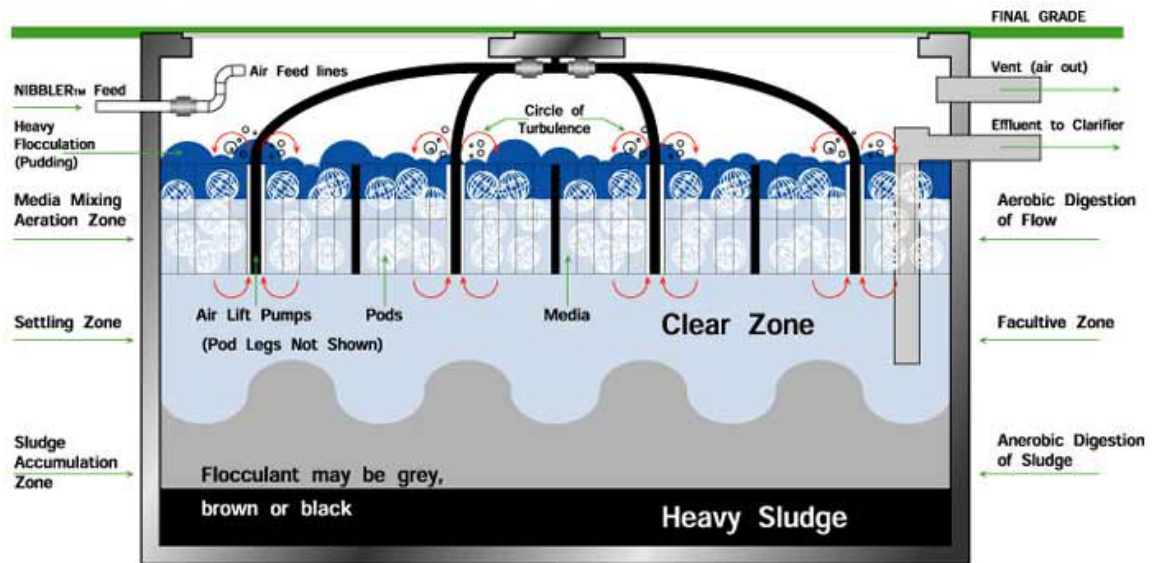


### Description of process

The Nibbler Jr. system is a standard septic tank with an aerated attached growth process in the second chamber. The basis of the Nibbler process is an aerated fixed film suspended packing. Wastewater flows into the treatment reactor and is drawn through the packing material with an air lift pump. A portion of the lifted water is discharged from the system and a portion is returned to the anoxic chamber (first chamber of septic tank) for denitrification.

### System footprint

Space requirements approximately equal to that needed for a standard septic tank.



**Figure 8-9**

Diagram of the Nibbler wastewater treatment systems. (Adapted from NCS wastewater solutions/Northwest Cascade-Stuth.)

### Advantages

All operations occur in a single basin, and it can be installed in an existing septic tank, resulting in relatively small space requirements. In case of air lift pump (blower) failure, the system can gravity discharge.

### Disadvantages

The Nibbler system requires a blower for aerobic operation.

### Performance

The data reported in Table 8-8 have been obtained for the Nibbler Jr. wastewater treatment unit, based on 15 samples from the Anne Arundel County National Onsite Demonstration Project.

**Table 8-8**

Performance of the Nibbler Jr. treatment system (Anne Arundel NODP, 2001)

Parameter	Unit	Influent	Effluent	Removal
BOD	mg/L	236	34	86%
TSS	mg/L	109	24	64%
TN	mg/L	58	28	52%
Fecal Coliform	MPN/100 mL	3.2E6	1E4	2.5 log

**Operation and maintenance**

Required management contract, inspection every six months (including sampling for high strength applications, sludge removal when needed, and blower maintenance), 3 year warranty on parts and labor.

**Power and control**

The estimated annual power usage for the aeration system, alarm, and controls is 1,000 to 2,000 kWh.

**Contact**

NCS wastewater solutions/Northwest Cascade-Stuth  
16207 Meridian East; PO Box 73399  
Puyallup, WA 98373  
Phone (800) 444-2371; (253) 848-2371  
Fax (253) 840-0877  
Web [www.ncswastewater.com](http://www.ncswastewater.com)

**References and other resources**

Anne Arundel County National Onsite Demonstration Project (2001) Nibbler Jr. wastewater treatment system performance.

Stuth WL and MM Lee (2001) Recovery of Failing Drainfields and a Sand Mound Using Aerobic Effluent, in *Proceeding of the Ninth National Symposium on Individual and Small Community Sewage Systems*, Fort Worth, TX, American Society of Agricultural Engineering, St Joseph, MI.

**8-3 Rotating Biological Contactor (RBC)**

The RBC system consists of rotating disks, partially submerged in the water to be treated. The disks are designed to maximize biomass attachment for biological wastewater treatment. Organisms suspended in the water and attached to the rotating disks provided treatment to the wastewater.

**8-3.1 Biokreisel™**

Category	Secondary treatment
Technology	Continuous flow, aerated attached growth
Input	Primary (settled) wastewater
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual residential systems

**Background**

The Biokreisel unit was developed in Germany and has been certified by NSF and is currently being evaluated in the La Pine Onsite Demonstration Project in Oregon. The unit is composed of two chambers, a treatment chamber (375 gal) and a settling chamber (199 gal).

**Description of process**

Primary effluent from the septic tank flows into the treatment side of the Biokreisel. In the treatment section, a partially submerged attached growth packing rotates continuously. As the packing rotates, the attached microbial community is intermittently exposed to the wastewater. With each rotation, cups attached to the packing material lift a portion of the wastewater and sloughed biofilm and then deposit it into a pipe for return to the septic tank (recirculation flow). The treated water is lifted into a settling chamber with the screw auger in the center of the rotating packing. Sludge that accumulates in the settling chamber is also sent back to the septic tank.

**System footprint**

The Biokreisel unit has a diameter of 8.75 ft and a depth of 5.8 ft. A primary treatment device, such as a septic tank, and a soil adsorption system are also needed.

**Advantages**

The Biokreisel system provides effective wastewater treatment. The recirculation feature buffers the system when there is no household wastewater output. An alarm system for monitoring the process will alert the system owner in the event of a malfunction.

**Disadvantages**

The process requires electricity to power the motor.

**Performance**

Effluent concentrations of BOD<sub>5</sub> and TSS less than 10 mg/L are expected from the Biokreisel system; there is also potential for total nitrogen removal in range of 70% (NSF 1997).

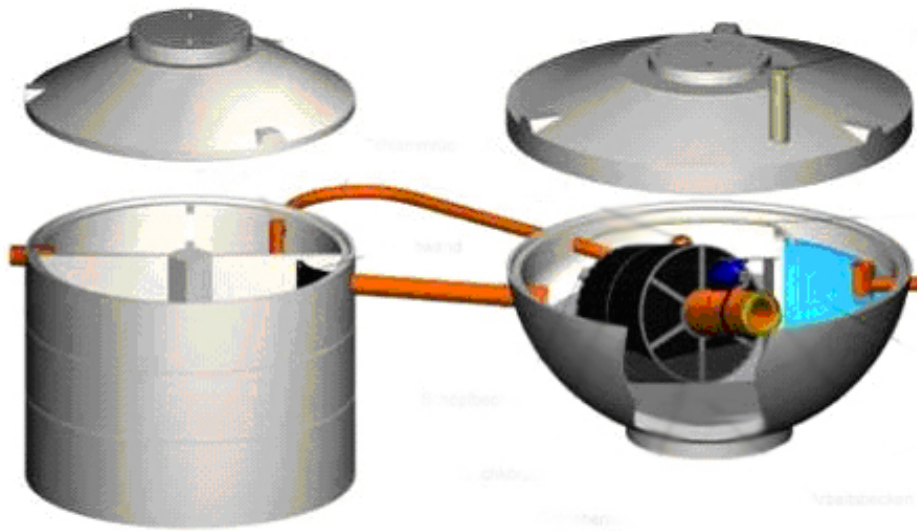
**Figure 8-10**

Illustration of the Biokreisel wastewater treatment system. (Adapted from Nordbeton North America, Inc.)

**Operation and maintenance**

The manufacturer recommends shutting the unit off if the system is not to be used for more than 8 weeks (i.e., vacation). The septic tank requires solids removal as needed. The system owner needs to confirm system is running (especially after power outage), check for alarm messages, watch for signs of malfunction (water backup, odors), and schedule regular service. On a six month basis, the service company checks for proper operation, sludge accumulation, excess biomass growth, and performs a qualitative effluent check. A control system monitors for high water conditions in the treatment unit, alarm interruption, operation of pump, and operation of the motor.

**Power and control**

The system components that require electricity include a control panel, alarms, drive motor, and sludge return pump. The estimated annual electricity usage for the Biokreisel system is 1,000 kWh.

**Cost**

The estimated cost for a single unit ranges from \$5,000 to \$6,000 (based on Models BK-250NA and BK-252NA), and includes capital cost for Biokreisel only (delivery, installation, etc. not included).

**Contact**

BIOKREISEL; Nordbeton North America, Inc.

P.O. Box 470858

Lake Monroe, FL 32747

Phone (407) 322-8122

Fax (407) 322-8159

Web [www.nordbeton.com](http://www.nordbeton.com)

**Model description**

BK-250NA (400 gal/d)

BK-251NA (500 gal/d)

BK-252NA (600 gal/d)

**Manufacturer support**

Manufacturer provides a limited warranty on system and service contract for first two years after installation included in purchase price. After two years service contract expires, owner is given opportunity to renew service agreement.

**References and other resources**

NSF (1997) Performance Evaluation Report: Nordbeton GmbH Model BK-252NA Wastewater Treatment System, NSF International, Ann Arbor, MI.

**8-3.2 Biorotor™**

Category	Primary and secondary treatment
Technology	Continuous flow, attached growth
Input	Untreated wastewater
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Community systems

**Background**

The Biorotor system is composed of a primary treatment system (such as a septic tank), an RBC aeration unit, and a secondary clarification system.



**Figure 8-11**

The Biorotor treatment system shown with a fiberglass septic tank. (Adapted from NPS Wastewater Treatment Systems Limited.)

**Operation and maintenance**

Typical operation and maintenance includes sludge removal, bearing lubrication, and process monitoring. Monthly service is provided by a manufacturer certified technician.

**Contact**

NPS Wastewater Treatment Systems Limited

Unit 3, 1974 Spicer Rd

N Vancouver, BC V7H 1A2

Phone (604) 924-1085; (877) 712-2233

Fax (604) 924-1785

E info@npswastewater.com

Web www.npswastewater.com

**Model description**

Units available for treatment of flow rates from 3,000 to 30,000 gal/d.

**Manufacturer support**

Telemetry systems available for process monitoring.

**8-3.3 CMS Rotordisk™**

Category	Primary and secondary treatment
Technology	Continuous flow, attached growth
Input	Untreated wastewater
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Community systems

**Background**

The Rotordisk unit combines primary settling, biological oxidation, final settling, and sludge storage in one integrated system. The system is entirely enclosed, and therefore ideal for situations where odor control, noise reduction, and visual impact must be considered. If required, advanced wastewater treatment options can be added to the standard Rotordisk to provide tertiary filtration, nitrification, disinfection or phosphorus reduction (CMS Group Inc., 2001).

**Figure 8-12**

The Rotordisk treatment system installed at a residential location. (Adapted from CMS Group Inc.)

### Contact

CMS Group Inc.  
185 Snow Blvd. Suite 200  
Concord, Ontario, Canada L4K 4N9  
Phone (905) 660-7580  
Fax (905) 660-0243  
E cms@rotordisk.com  
Web www.rotordisk.com  
Model description

Units available for treatment of flow rates from 500 to 100,000 gal/d.

### 8-3.4 Five Star Environmental KR505

Category	Primary and secondary treatment
Technology	Continuous flow, attached growth
Input	Untreated wastewater
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual systems

### Background

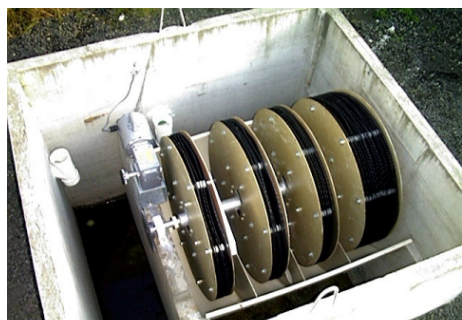
The Five Star RBC unit (Model 505-KR) is an integrated primary and secondary treatment system. Primary effluent flows into the second compartment which houses a series of partially submerged rotating disks. Organisms attached to the disk are alternately exposed to the wastewater and the atmosphere as the disks rotate.

### Operation and maintenance

Typical operation and maintenance includes sludge removal and confirmation of alarm operation.

### Performance

The Five Star 505-KR is certified under the NSF standard 40 to provide secondary quality effluent.



**Figure 8-13**

The Five Star Model 505-KR treatment system. (Adapted from Five Star Environmental Systems, Inc.)

### Contact

Five Star Environmental Systems, Inc.  
P.O. Box 1768  
Kingston, WA 98346  
Phone 360.297.3633  
Fax 360.297.3636  
Web www.fivestarenviro.com



### 8-3.5 Klargester Biodisk™

Category	Primary and secondary treatment
Technology	Continuous flow, rotating biological contactor
Input	Untreated wastewater
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual, community, and larger systems

#### Background

The Klargester Biodisk is an integrated primary and secondary treatment system.

#### Performance

The Klargester Biodisk has been evaluated at the Florida Keys Onsite Wastewater Nutrient Reduction Systems (OWNRS) Demonstration Project. The results from Phase I and II of the OWNRS project are presented in Table 8-9. Note that the performance values provided for the Florida Keys OWNRS Project are for a coupled Klargester Biodisk and anoxic upflow biofilter.

**Table 8-9**

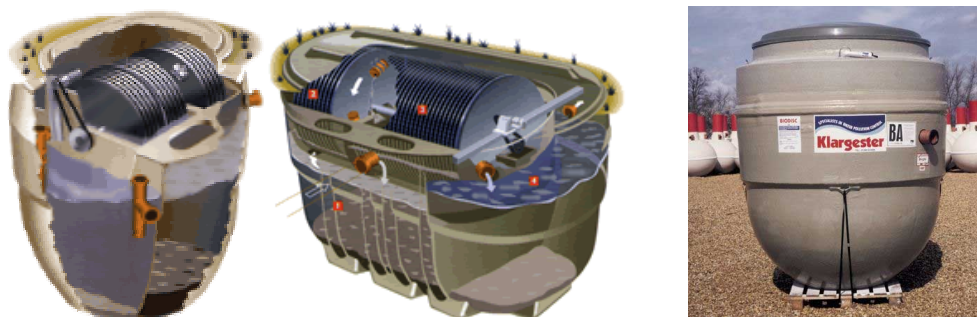
Results from Phase I and II of the Florida Keys OWNRS Project

Parameter	Unit	Location of study	
		Florida <sup>a</sup>	Florida <sup>b</sup>
Description of system		Test facility	Test facility
HLR	gal/d	307	
System performance <sup>c</sup>			
BOD <sub>5</sub>	mg/L	2.42 (99%)	2.42 (99%)
TSS	mg/L	5.75 (95%)	14 (85%)
TN	mg/L	12.52 (67%)	14.9 (69%)
NO <sub>3</sub> -N	mg/L	9.77	13
TP	mg/L	4.67 (44%)	6.8 (22%)

<sup>a</sup> Florida Department of Health (2000).

<sup>b</sup> Anderson *et al.* (1998).

<sup>c</sup> Performance reported as average effluent concentration with average removal in parentheses, where applicable.



**Figure 8-14**

Cut-away illustrations of two types of Klargester RBC units (left) and a system prior to installation (right). (Adapted from Klagerster Environmental Ltd.)

**Contact**

Klargester Biodisk; Klargester Environmental Ltd.  
College Road, Aston Clinton  
Aylesbury, Bucks. HP22 5EW  
Phone  
Web [www.klargester.co.uk](http://www.klargester.co.uk)

**Local Contact**

Waste Water Solutions International Inc.  
3238 Old Fence Road  
Ellicott City, MD 21042  
Phone (410) 480-0272  
Fax (410) 480-0282  
E [wwsi@worldnet.att.net](mailto:wwsi@worldnet.att.net)

**References and other resources**

Anderson DL, MB Tyl, RJ Otis, TG Mayer, KM Sherman (1998) Onsite Wastewater Nutrient Reduction Systems (OWNRS) for Nutrient Sensitive Environments, in *Proceeding of the Eighth National Symposium on Individual and Small Community Sewage Systems, Orlando, FL*, American Society of Agricultural Engineering, St Joseph, MI.

**8-3.6 RotoFix™**

Category	Primary and secondary treatment
Technology	Continuous flow, attached growth
Input	Untreated wastewater
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Community, commercial, institutional

**Background**

The RotoFix rotating biological contactor is an aerobic, semi-submerged fixed culture biological treatment system for domestic wastewater in commercial, institutional, community, and municipal applications (Premier Tech Environment, 2001).

**Description of process**

The RotoFix consists of a patented, tubular PVC medium with multiple internal blades offering a large contact surface per unit of volume of liquid. Numerous media channels are radially arranged around a horizontal, stainless steel shaft and secured by end plates and a central plate of polymer to form the RotoFix rotor assembly (Premier Tech Environment, 2001).

**Figure 8-15**

View of the Premier Tech RotoFix RBC medium used for biological attached growth. (Adapted from Premier Tech Environment.)

**Contact**

Premier Tech Environment  
6021 Terrace Hills Dr  
Birmingham, AL 35242  
Phone (205) 408-969; (877) 295-5763  
Fax (205) 408-8783  
E [ecoflo@premiertech.com](mailto:ecoflo@premiertech.com)  
Web [www.premiertech.com](http://www.premiertech.com)



## 8-4 Sequencing batch reactor

The SBR process discussed below is identical to the SBR process described in Chap. 7, with the addition of an attached growth material for the biological treatment stage of the process.

### 8-4.1 *Amphidrome™*

Category	Primary and secondary treatment
Technology	Continuous flow, submerged fixed film sequencing reactor
Input	Primary effluent (septic tank)
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Single family homes, cluster and commercial systems from 5,000 to 36,000 gal/d

#### Background

The Amphidrome process is an advanced biological wastewater treatment system that utilizes a fixed film, sequencing batch biofilter. The system consists of a deep bed filter that alternates between aerobic and anoxic treatment. The design allows for the nitrification and denitrification of the waste stream to be carried out in a single reactor.

#### Description of process

The process consists of aerobic, anoxic, recirculation, and discharge cycles. In the aerobic portion of the cycle, primary effluent flows down through a fixed film media as air is supplied from below by an air blower. The media is an attached growth media in a bed of silica sand supported by a layer of gravel. As the air flows up through the media, the air bubbles are sheared by the sand, thus producing a fine even pattern throughout the bed. The cyclical action of the system is created by allowing a batch of wastewater to pass from the anoxic/equalization tank through the aerated granular biological filter into the clear well, and then reversing the flow back through the biofilter through the use of a pump. The reverse flow passes from the clear well up through the filter, where it overflows into a trough that carries it back to the anoxic/ equalization tank. The aerobic/anoxic cycles are repeated multiple times. Once sufficient cycles have been repeated to insure the degree of treatment required, a batch of effluent is discharged. Periodically, the deep bed filter in the reactor has to be backwashed. This is accomplished by simultaneously pumping water, back from the clearwell, and blowing air, at a high volume, into the Amphidrome Reactor.

#### System footprint

Requires two basins in addition to a standard septic tank. High quality effluent may be discharged to soil treatment systems or alternate effluent management system.

#### Advantages

The use of a septic tank buffers the system by providing flow and constituent equalization.

#### Disadvantages

Mechanically and energy intensive process. Operation and maintenance intensive and reliant on SCADA controls for adjusting process controls.

#### Performance

Performance specifications of representative research findings are presented in Table 8-10.

#### Operation and maintenance

Quarterly inspection of pumps, control devices, and blowers is recommended. Sludge removal from the septic tank may be needed periodically.

#### Power and control

Process uses four float alarm/switches, two pumps, an air blower, and process control panel. The annual electrical usage is estimated to be 800 to 1,000 kWh.

**Cost**

Capital cost for Amphidrome components are estimated to be \$10,000, (does not include septic tank). The total installed cost ranges from \$12,000 to 14,000 for an individual residence.

**Table 8-10**

Reported results from Buzzards Bay Project  
for the Amphidrome treatment process<sup>a</sup>

Parameter	Unit	Location of study
		Massachusetts <sup>b</sup>
Description of system		Test facility
HLR	gal/d	330
System performance		
BOD <sub>5</sub>	mg/L	17 (90%)
TSS	mg/L	8 (95%)
TN	mg/L	14.9 (47%)
NO <sub>3</sub> -N	mg/L	3
Fecal coliform	No./100 mL	4E5 (1)

<sup>a</sup> Massachusetts Alternative Septic System Test Center (2001).

<sup>b</sup> Performance reported as average effluent concentration with average removal in parentheses, except fecal coliform removal which is reported as logs of removal.

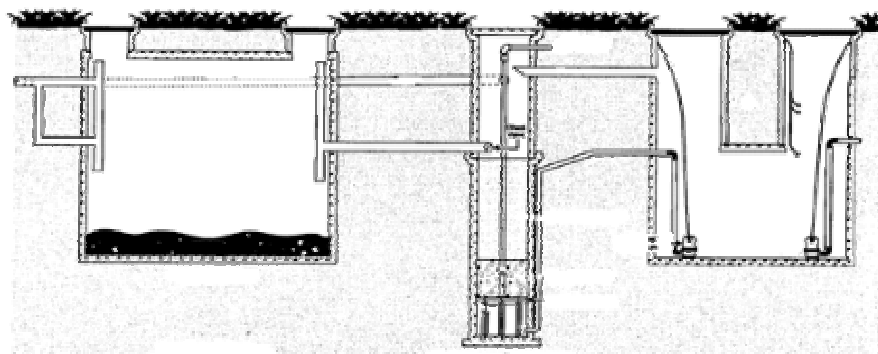
**Figure 8-16**

Diagram of the Amphidrome process (top) and installation of the Amphidrome at the Massachusetts Alternative Septic System Test Center (bottom). (Adapted from F.R. Mahony & Associates.)

**Contact**

F.R. Mahony & Associates  
131 Weymouth St., Rockland, MA 02370  
Phone (781)982-9300  
Fax (781)982-1056  
Web [www.frmahony.com](http://www.frmahony.com)

**Model description**

The basic residential model is designed for a single family home with a flow rate of 330 to 440 gal/d, the process has been expanded to treat up to 36,000 gal/d.

**References and other resources**

Massachusetts Alternative Septic Test Center (2001) Technology Fact Sheet Interim Findings: Amphidrome, Buzzards Bay Project.

U.S. EPA (2001) *CEIT Virtual Trade Show: Amphidrome Wastewater Treatment Systems* (available at [www.epa.gov/region1/steward/ceitts/wastewater/techs/amphidrome.html](http://www.epa.gov/region1/steward/ceitts/wastewater/techs/amphidrome.html)).

